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edge that the study of nature's secrets is the ordained method by which the greatest good and happiness shall finally come to the human race.

Where, then, are the greatest laboratories of research in this city, in this country, nay, in the world? We see a few miserable structures here and there occupied by a few starving professors who are nobly striving to do the best with the feeble means at their disposal. But where in the world is the institute of pure research in any department of science with an income of \$100,000,000 per year. Where can the discoverer in pure science earn more than the wages of a day laborer or cook? But \$100,000,000 per year is but the price of an army or a navy designed to kill other people. Just think of it, that one per cent. of this sum seems to most people too great to save our children and descendants from misery and even death!

But the twentieth century is near—may we not hope for better things before its end? May we not hope to influence the public in this direction?

Let us go forward, then, with confidence in the dignity of our pursuit. Let us hold our heads high with a pure conscience while we seek the truth, and may the American Physical Society do its share now and in generations yet to come in trying to unravel the great problem of the constitution and laws of the Universe.

HENRY A. ROWLAND.

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*CRUISE OF THE ALBATROSS.*

THE following letter has been received by the U. S. Fish Commission from Professor Alexander Agassiz. It is dated Papeete Harbor, Tahiti Island, September 30, 1899, and gives an account of the voyage of the *Albatross* up to that time.

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I arrived at San Francisco on August 20th, and after consulting with Commander

Moser we decided to leave on Wednesday, the 23d. Everything shipped from the east had arrived with the exception of the tow nets sent me by Dr. Kramer, and the deep-sea nets kindly ordered for me by Professor Chun of Leipzig. Captain Moser and I decided not to make any soundings nor do any deep-sea work until we had passed beyond the lines of soundings already run by the *Albatross* and *Thetis* between California and the Hawaiian Islands.

In latitude  $31^{\circ} 10'$  N., and longitude  $125^{\circ}$  W., we made our first sounding in 1955 fathoms, about 320 miles from Point Conception, the nearest land. We occupied 26 stations until we reached the northern edge of the plateau from which rise the Marquesas Islands, having run from station No. 1, a distance of 3800 miles, in a straight line.

At station No. 2 the depth had increased to 2368 fathoms, the nearest land, Guadeloupe Island, being about 450 miles, and Point Conception nearly 500 miles distant. The depth gradually increased to 2628, 2740, 2810, 2881, 3003, and 3088 fathoms, the last in lat.  $16^{\circ} 38'$  N., long.  $130^{\circ} 14'$  W., the deepest sounding we obtained thus far in the unexplored part of the Pacific through which we are passing. From that point the depths varied from 2883 to 2690 and 2776, diminishing to 2583, and gradually passing to 2440, 2463, and 2475 fathoms, until off the Marquesas, in lat.  $7^{\circ} 58'$  S., long.  $139^{\circ} 08'$  W., the depth became 2287 fathoms. It then passed to 1929, 1802, and 1040 fathoms, in lat.  $8^{\circ} 41'$  S., long.  $139^{\circ} 46'$  W., Nukuhiva Island being about 30 miles distant. Between Nukuhiva and Houa-Houna (Ua-Huka) islands we obtained 830 fathoms, and 5 miles south of Nukuhiva 687 fathoms. When leaving Nukuhiva for the Paumotus we sounded in 1284 fathoms about 9 miles south of that island. These soundings seem to show that this part of the Marquesas rises from a

plateau having a depth of 2000 fathoms, and about 50 miles in width, as at station No. 29 we obtained 1932 fathoms.

Between the Marquesas and the north-western extremity of the Paumotus we occupied 9 stations, the greatest depth on that line being at station No. 31, in lat.  $12^{\circ} 20' S.$ , and long.  $144^{\circ} 15' W.$  The depths varied between 2451 and 2527 fathoms, and diminished to 1208 fathoms off the west end of Ahii, and then to 706 fathoms when about 16 miles N. E. of Avatoru Pass in Rairoa Island.

We developed to a certain extent the width of the Paumotu group plateau by a line of soundings in continuation of the direction of Avatoru Pass, extending a little less than 9 miles seaward where we obtained a depth of 819 fathoms. Subsequently we ran a similar line normal to the south shore of the lagoon of Rairoa a distance of nearly 12 miles into 897 fathoms.

Between Rairoa and Tikehau, the next island to the westward, we got a depth of 1486 fathoms.

Between Tikehau and Mataiwa 6 soundings were made with a depth of 488 fathoms half a mile from shore, and a greatest depth of 850 fathoms  $6\frac{1}{2}$  miles from Tikehau. The slope approaching Mataiwa is steeper than the Tikehau slope.

From Mataiwa to Makatea (Aurora) Island, we made 6' soundings: from 642 fathoms about  $2\frac{1}{2}$  miles off shore, to 581 fathoms about  $1\frac{1}{8}$  miles off the west side of the latter island, the depths passing to 860, 1257, 1762, and the greatest depth being 2267 fathoms; then 2243, and rising more rapidly near Makatea to 851 fathoms.

Between Makatea and Tahiti we made 8 soundings, beginning with 1363 fathoms, 2 miles off the southern end of Makatea, passing to 2238, 2363 (the greatest depth on that line), 2224, 1930, 1585, 775, and finally 867 fathoms off Point Venus.

These make in all 72 soundings up to the present time.

The deep basin developed by our soundings between lat.  $24^{\circ} 30' N.$ , and lat.  $6^{\circ} 25' S.$ , varying in depth from nearly 3100 fathoms to a little less than 2500 fathoms, is probably the western extension of a deep basin indicated by two soundings on the charts, to the eastward of our line, in longitudes  $125^{\circ}$  and  $120^{\circ} W.$ , and latitudes  $9^{\circ}$  and  $11^{\circ} N.$ , one of over 3100 fathoms, the other of more than 2550 fathoms, showing this part of the Pacific to be of considerable depth, and to form a uniformly deep basin of great extent, continuing westward probably, judging from the soundings, for a long distance.

I would propose, in accordance with the practice adopted for naming such well-defined basins of the ocean, that this large depression of the Central Pacific, extending for nearly  $30^{\circ}$  of latitude, be named Moser Basin.

The character of the bottom of this basin is most interesting. The haul of the trawl made at station No. 2, lat.  $28^{\circ} 23' N.$ , long.  $126^{\circ} 57' W.$ , brought up the bag full of red clay and manganese nodules with sharks' teeth and cetacean ear-bones; and at nearly all our stations we had indications of manganese nodules. At station No. 13, in 2690 fathoms, lat.  $9^{\circ} 57' N.$ , long.  $137^{\circ} 47' W.$ , we again obtained a fine trawl haul of manganese nodules and red clay; there must have been at least enough to fill a 40-gallon barrel.

The nodules of our first haul were either slabs from 6 to 18 inches in length and 4 to 6 inches in thickness, or small nodules ranging in size from that of a walnut to a lentil or less; while those brought up at station No. 13 consisted mainly of nodules looking like mammillated cannon balls varying from  $4\frac{1}{2}$  to 6 inches in diameter, the largest being  $6\frac{1}{2}$  inches. We again brought up manganese nodules at the Equa-

tor in about longitude  $138^{\circ}$  W., and subsequently—until within sight of Tahiti—we occasionally got manganese nodules.

As had been noticed by Sir John Murray in the *Challenger*, these manganese nodules occur in a part of the Pacific most distant from continental areas. Our experience has been similar to that of the *Challenger*, only I am inclined to think that these nodules range over a far greater area of the Central Pacific than had been supposed, and that this peculiar manganese-nodule bottom characterizes a great portion of the deep parts of the Central Pacific where it cannot be affected by the deposit of globigerina, pteropods, or telluric ooze; in the region characterized also by red-clay deposits. For in the track of the great equatorial currents there occur deposits of globigerina ooze in over 2400 fathoms for a distance of over 300 miles in latitude.

Manganese nodules we found south of the Marquesas also, where in 2700 fathoms we obtained, perhaps, the finest specimens of red clay from any of our soundings. As we approached close to the western Paumotus, and rose upon the plateau from which they rise, globigerina ooze passed gradually to pteropod ooze, then to fine and coarse coral sand. In the channel south of the Paumotus to Tahiti the coral sand passed to volcanic sand mixed with globigerinæ in the deepest parts of the line, and toward Tahiti passed to volcanic mud mixed with globigerinæ, next to fine volcanic sand, and finally, at the last sounding, off Point Venus, to coarse volcanic sand.

We made a few hauls of the trawl on our way, but owing to the great distance we had to steam between San Francisco and the Marquesas (3800 miles) we could not, of course, spend a great deal of time either in trawling or in making tows at intermediate depths. Still the hauls we made with the trawl were most interesting, and confirmed what other deep-sea expeditions have real-

ized: that at great depths, at considerable distances from land and away from any great oceanic current, there is comparatively little animal life to be found. Where manganese nodules were found the hauls were specially poor, a few deep-sea holothurians and ophiurans, and some small actiniæ which had attached themselves to the nodules with a few other invertebrates, seemed to be all that lived at these great depths, 2500 to 2900 fathoms, far away—say from 700 to 1000 miles—from the nearest land.

The bottom temperatures of the deep (Moser) basin varied between  $34.6^{\circ}$  at 2628 and 2740 fathoms, to  $35.2^{\circ}$  at 2440 fathoms, and  $35^{\circ}$  at 2475 fathoms; about 120 miles from the Marquesas. At station No. 23, off the Marquesas, in 1802 fathoms, the temperature was  $35.5^{\circ}$ .

Owing to the failure of our deep-sea thermometers we were not able to make any satisfactory serial-temperature observations. At station No. 11, lat.  $14^{\circ} 38'$  N., long.  $136^{\circ} 44'$  W., we obtained:  $79^{\circ}$  at surface,  $78.7^{\circ}$  at 50 fathoms,  $55.9^{\circ}$  at 100 fathoms,  $48.9^{\circ}$  at 200 fathoms,  $44.1^{\circ}$  at 300 fathoms, and  $38.9^{\circ}$  at 700 fathoms. These temperatures are somewhat higher than those obtained by the *Challenger* in similar latitudes on their line to the westward of ours between the Sandwich Islands and Tahiti.

The temperatures of the bottom between the Marquesas and Paumotus were  $34.9^{\circ}$  at 1932 fathoms,  $35^{\circ}$  at 2456 fathoms and 2451 fathoms, and  $35.1^{\circ}$  at 2527 fathoms.

We did not take any bottom temperatures between the Paumotus and Tahiti.

Our deep-sea nets not having reached San Francisco at the time we sailed, we limited our pelagic work to surface hauls, of which we generally made one in the morning and one in the evening, and whenever practicable some hauls with the open tow nets at depths varying between 100 and 350 fathoms. The results of these hauls

were very satisfactory. The collection of surface animals is quite extensive, and many interesting forms were obtained. As regards the deeper hauls, they only confirm what has been my experience on former expeditions: that beyond 300 to 350 fathoms very little animal life is found, and in the belt above 300 fathoms, the greater number of many so-called deep-sea crustaceans and deep-sea fishes were obtained. I may mention that we obtained *Pelagothuria* at about 100 fathoms from the surface.

We trawled at station No. 10 in 3088 fathoms. Unfortunately the trawl was not successful, and we simply hauled the bag through over 3000 fathoms without bringing up a single deep-sea animal from intermediate depths which we did not obtain quite near the surface—at less than 300 fathoms. I may mention here that the experience of the *Valdivia* shows, from the preliminary reports published by Professor Chun, that no pelagic algae extend to beyond about 150 fathoms. Although he also states that animal life is found at all depths from the surface to the bottom, yet he states that beyond 800 meters it diminishes *very rapidly*. Professor Chun does not state whether this diminution is more rapid away from land than near continental areas, both of which conditions I had called especial attention to in my preliminary report on the *Albatross* expedition of 1891, while using the Tanner net in the Gulf of California. Mr. George Murray has criticised the action of the Tanner deep-sea net and condemns its results, suggesting that the bottom net had always closed some time after being sent down. I need not now discuss that subject, but will only refer him to the report of the *Albatross*, in which he will find the closed part of the net to have on several occasions brought up (when I expected it to do so) specimens from over 600 fathoms from immediately above the bottom, or samples of the bottom from near

1700 fathoms while attempting to tow immediately above that depth. I ought, in justice to him, to state that I omitted to mention that we secured the loops by twine to the detacher, to insure their dropping only when the messenger reached the detacher, and that the hooks of the detacher were lengthened very considerably above the dimensions figured in my preliminary report on the *Albatross* in 1891. I might add that we made a number of trials near the surface to see the action of the Tanner net under all conditions of position and speed, and I can only assume that Mr. Murray, having no experience, did not handle his net properly, or that it was not properly balanced. I may also add that Captain Tanner used his modified net subsequently in the *Albatross*, while running a line of soundings from San Francisco to Hawaiian Islands, in from 100 to 350 fathoms from the surface, at considerable distances from the islands and the mainland, and also in Alaskan waters, and always with the results we had obtained before. The closed bag, when towing at 100 fathoms below the surface, always brought up a mass of pelagic animals living at about that depth, while when tried at 300–350 fathoms, it brought up little or nothing. There is nothing in Captain Tanner's experience, or mine, to indicate why the net should act well at 100 fathoms and not well at 300 fathoms or more, as suggested by Mr. Murray.

On our way to Tahiti from the Marquesas we stopped a few days to examine the westernmost atolls of the Paumotus. Striking Ahii we made for Rairoa, the largest of the Paumotu group, skirting the northern shore from a point a little west of Tiputa Pass; we entered the lagoon through Avatoru Pass, anchoring off the village. This pass is quite narrow, with a strong current running out the greater part of the time, especially in easterly winds. It varies in

depth between 9 and 10 fathoms, shoaling near the inner entrance to about  $3\frac{1}{2}$  fathoms, and deepening again to 6 or 7 fathoms, and gradually passing into 15 to 17 fathoms, which is the average depth of the lagoon from Avatoru Pass to the south or weather shore, a distance of about 13 miles.

We made an examination of the northern side of the lagoon, between Avatoru and Tiputa passes. The lagoon beach of the northern shore is quite steep, and is composed of moderately coarse broken coral sand at the base, and of larger fragments of corals along the upper face, which is about 5 to 6 feet above high-water mark. These coral fragments are derived in part from the corals living on the lagoon face of the northern shore, and in part of fragments broken by the waves from somewhat below the low-water mark. The ledge which underlies the beach crops out at many places on the lagoon side of the northern shore; we traced it also along the shores of Avatoru Pass, and about half way across the narrow land running between Avatoru and Tiputa passes. It crops out also at various points between them in the narrow cuts which divide this part of the northern land of the lagoon into a number of smaller islands. These secondary passes leave exposed the underlying ledge, full of fossil corals. In some cases there is left a clear channel extending across from the lagoon to the northern side through which water flows at high or half tide. In other cases the cuts are silted up with coral sand blown in from the lagoon side. In others, the cut is shut off by a high sand-bank, or a bank composed of broken fragments of corals, leaving access to the water from the northern shore only; and finally the cuts are also shut off on the northern side by sand and broken coral banks, the extension of the north-shore beach leaving a depression which at first is filled with salt water and gradually silted up both from the

lagoon side and the sea side, and forms the typical north shore land of the lagoon. This building up of the land of the Paumotu atolls simultaneously both by the accumulation of sand from the lagoon side and the sea face is very characteristic of the atolls of that group. It is a feature which I have not seen so marked in any other coral reef district.

On the lagoon side the slope from the beach is very gradual into 16 and 17 fathoms, and corals appear to flourish on the lagoon slope to 6 or 8 fathoms only, in some cases consisting of Madrepores, *Porites*, *Astræans*, and *Pocillopores*. The corals could be seen over the floor of the Avatoru Passage down to 9 to 10 fathoms; and on the sea face *Pocillopores* covered the outer edge of the shore platform. This platform is from 200 to 250 feet wide, and was formed by the planing off of the seaward extension of the ledge cropping out in the cuts.

It became very evident, after we had examined the south shore of the lagoon, that the ledge underlying the north shore is the remnant of the bed, an old tertiary coralliferous limestone, which at one time covered the greater part of the area of the lagoon, portions of which may have been elevated to a considerable height. This limestone was gradually denuded and eroded to the level of the sea. Passages were formed on its outside edge, allowing the sea access to the inner parts of the lagoon. This began to cut away the inner portions of the elevated limestone, forming large sounds, as in the case of Fiji atolls, and leaving finally on the south side only a flat strip of perhaps 2500 to 3000 feet in width which has gradually been further eroded on the lagoon side and also on the sea face to leave only a narrow strip of land about 1000 feet in width and perhaps 10 to 14 feet in height, the material for this land having come from the disintegration of the ledge of tertiary limestone, both on the sea face and the lagoon side.

There exist at the lagoon side of both Avatoru and Tiputa passes a number of small islets which also consist of this same tertiary limestone in process of disintegration and transformation to coral sand islets; two of these we found along our line of soundings, the one about  $4\frac{1}{2}$  miles from the north side of the lagoon, and the other about the same distance from the south shore. I am told that the eastern extremity of the lagoon is filled with islets and heads consisting of the same limestone rock so characteristic of the north and south shores of the lagoon.

The underlying ledge is not the remnant of a modern reef; its character is identical with that of the elevated limestones of Fiji which are of tertiary age, and the rock is in every respect the same as that I observed on many of the elevated islands of Fiji. The atoll of Rairoa is in a stage of denudation and erosion very similar to that of Ngele Levu, in Fiji, only in Ngele Levu the elevated limestone attains a height of about 60 feet. Our visit to the south shore of the lagoon, both on the lagoon side and on the sea face, left us no doubt regarding the character of the underlying ledge of the north shore. As soon as the south shore was sufficiently near, as seen from the lagoon side, for us to distinguish its character, we could see that the entire shore line was formed of a high ledge of limestone, honeycombed, pitted, and eroded, both by atmospheric agencies and the action of the waves in its lower parts both on the lagoon side and on the sea face. The great rollers of the weather side broke through between the columnar masses of the ledge into the lagoon, and as far as the eye could reach there extended a more or less continuous wall (which is described by Dana as he saw it sailing by in the *Vincennes*). But, on landing, we found this wall to be the sea face of the islands and islets which dot the weather side for the greater part of its length on the southwestern part of the lagoon. These islands and

islets are entirely composed of coral sand and coral fragments, formed from the disintegration of the extension of the elevated ledge toward the inside of the lagoon to a distance of about  $1\frac{1}{2}$  to 2 miles; and along this very gradual slope of the islands forming the southern edge of Rairoa, corals grow profusely down to 6 or 7 fathoms of water, when the bottom runs into hard coralline bottom similar to that found on all the soundings taken across the lagoon.

The width of the larger islands is about 1000 to 1200 feet, the smaller islands and islets are less, some of the latter forming in reality mere sand buttresses at right angles to the great limestone ledge which flanks them all on the sea face and connects them on the weather side as if by a great wall, more or less broken, and shuts off the communication of the interior of the lagoon with the sea on that side.

The passages between the islands and islets illustrate well, only on a larger scale, the formation of the cuts, more or less silted up, which were observed on the northern face of the lagoon. Some of these passages are dry at low-water, others are partly filled by tide pools, others are entirely silted up by lagoon sand, only they are lower than the sand-blown land of the islands on either side.

Crossing over to the weather side of the southern land of Rairoa, in one of the passages between two of the islands we came upon the limestone ledge, from 12 to 14 feet high and about 40 to 50 feet wide, which formed the sea face of the islands and islets, and extended far to the westward as a great stone wall more or less broken into distinct parts. We found this ledge to consist of elevated limestone as hard as calcite, full of corals, honeycombed and pitted, and worn into countless spires and spurs, and needles and blocks of all sizes and shapes, separated by deep crevasses or potholes, recalling a similar scene in Ngele Levu on the windward side of the lagoon. In the pas-

sages the parts of the ledge which had not been eroded extended as wide buttresses, gradually diminishing in height till they formed a part of the lagoon flat and extended out below the recent beach rock which covered it in short stretches.

The slope of the sea face of the elevated ledge was quite steep and similar to the lagoon slope, its upper surface weathered by atmospheric and aqueous agencies into all possible shapes such as I have mentioned. The slope passed into the shore platform which was shaved down as it were to a general level surface. On the outer edge, within the line of the breakers, were growing *Pocillopores* in great abundance. This reef flat or shore platform, as well as the reef platform of the north shore, was strewn here and there with huge masses of the ledge of elevated reef rock torn from its outer shore. Similar rocks and boulders occur on the lagoon side of the islands forming the outer lands of Rairoa; they are either torn off from the lagoon face of the outercapping ledge, or are parts of the ledge which have remained in place and have not been planed down to the base level of the reef.

The amount of water which is forced into such a lagoon as Rairoa is something colossal, and when we observe that there are but a small number of passages through which it can find its way out again on the leeward side, it is not surprising that we should meet with such powerful currents (7 to 8 knots in several cases) sweeping out of the passages on the lee sides.

The islands and islets of Rairoa are fairly well covered with low trees and shrubs and great groves of palm trees.

The atolls of Tikehau and Mataiwa, which we also examined, present no features which we did not meet in Rairoa. The first-named atoll shows the same method of formation of the land by material piled up both from the lagoon side and the sea face; material

derived from the disintegration of the underlying tertiary limestone which crops out here and there along the sea face and the inner shores of the lagoon, or forms across the southwest face of the lagoon a more or less disconnected part of the ring of islands and islets encircling that end of the lagoon. These islets and islands are irregularly connected by fragments of the elevated limestone ledge, attesting its greater extension in past times. The outer rings of both these atolls are covered with vegetation. We could see in the lagoons several rocky islets, the fragments of the elevated limestone ledge.

Mataiwa is interesting, as its lagoon is quite shallow; it is full of rocky islets, remnants of the underlying limestone ledge which crops out above the general level, and has a very narrow and shallow entrance, passable for boats only. Some of its islands are wooded and appear to have been formed by accretions of sand from the decomposing ledges of the lagoon. The outer ring of land appears formed by sand banks driven in from the sea face and driven out from the lagoon side by the action of the waves. It is evident that such a lagoon as Mataiwa could readily be closed to any access to it by the sea, as it now has only one very narrow and very shallow boat passage connecting the lagoon with the sea on the lee side.

It was with great interest that we approached Makatea, as it is the only high elevated island of which Dana speaks as occurring in the western Paumotus. For though he mentions some others as possibly having been elevated 5 to 6 feet, yet he considered them, all as well as Makatea (Metia or Aurora, of Dana), as modern elevated reefs. Yet from the very description given by him of the character of the cliffs and of the surface of Makatea, I felt satisfied that it was composed of the same elevated coralliferous limestone so character-

istic of the elevated reefs of Fiji, and which, from the evidence of the fossils and the character of the rock, both Mr. Dall and myself have been led to regard as of tertiary age.

As we approached the island from the northwest it soon became evident that it presented all the characteristics to which I had become so accustomed in Fiji, and, upon landing, this was found to be the case. The cliffs had the same appearance as those of Vatu Leile, Ongea, Mango, Kambara, and many other elevated islands of Fiji. There were fewer fossils perhaps, but otherwise the petrographic character of the rock was identical with that of Fiji. Mr. Meyer collected upon the top of the second terrace a number of fossils similar in all respects to those we found in the Fiji elevated coralliferous limestones.

The southwestern extremity of the island sloped gradually to the sea and showed two well-defined terraces. The lines of these two terraces could, as a rule, be traced along the faces of the vertical cliffs by the presence of caverns along the lines of those levels, similar to the line of caverns indicating the line of present action of the sea at the base of the cliffs. As we steamed around the island there were distinct indications of two additional terraces on the line of the vertical cliffs on the weather side of the island. The position of these terraces was usually more clearly seen along the face of the cliffs at prominent points where they were undercut much as I have figured them for certain cliffs in Vatu Leile, in Fiji, in my report on the islands and coral reefs of that group.

Of course it is premature from this examination of the western extremity of the Paumotus to base any general conclusions regarding the mode of formation of these atolls; certainly as far as I have gone there is absolutely nothing to show that the atolls of the Paumotus have not been formed in

an area of elevation similar to that of Fiji. The evidence in Rairoa and in the atolls of the western Paumotus is very definite. Makatea is an elevated mass of coralliferous limestone similar in all respects to masses like Vatu Vara, Thithia, and others in Fiji. Like them Makatea is surrounded by a comparatively narrow shore platform cut out from the base of the limestone cliffs and on the seaward extension of which corals grow abundantly to depths of 7 to 8 fathoms, when they appear to become very much less numerous. So that it is not unnatural, as I am inclined to do, to look upon the area of the Paumotus as one of elevation, the raised and elevated land of which has been affected much in the same way by denudation and erosion as have the masses of elevated coralliferous limestone of Fiji. Only there seems to have been, from the evidence thus far presented, a far greater uniformity in the height of the elevation of the Paumotus. This would render the explanation I have given less evident had I not the experience of the Fiji group to guide me. I am informed that there are other islands and atolls in the Paumotu group, showing traces of this elevation, so that I am at any rate justified in denying that the Paumotus as such are situated in an area of subsidence and that subsidence has been the great factor, as is maintained by Darwin and Dana, in the formation of the characteristic atolls of the group.

It may be well to point out also that the Paumotus, like the Marquesas on one side and the Society Islands on the other, are situated upon a plateau similar to that upon which the last mentioned groups are placed—this plateau having a depth of from 1200 to 1500 fathoms and rising from the general oceanic basin which surrounds them and which has a depth of from 2300 to 2500 fathoms. Furthermore, evidence of this elevation is found at the two extremi-

ties of the Paumotu plateau, at Makatea, an elevated island consisting of tertiary coralliferous limestone and at the Gambier Islands which are volcanic islands of considerable height.

A. AGASSIZ.

*THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.*

II.

THE REVISED HARVARD PHOTOMETRY.

IN the Harvard Photometry, all stars were inserted having the magnitude 6.0 or brighter in any of the principal star catalogues then published. Accordingly, as was expected, many fainter stars were included, since a star really faint, but estimated bright by mistake in any of these catalogues, would be entered and measured. It appears that from this cause, and from the varying scale in different catalogues, more than six hundred stars are included, which are fainter than the magnitude 6.2 on the photometric scale. (See H. C. *Annals*, Vol. XIV., p. 479.) Numerous measures of the brighter stars have been made in recent years, with the large meridian photometer which has replaced the instrument first used. They include 823 stars measured in connection with fainter stars in Vol. XXIV., Table I., and 1179 stars in Vol. XXIV., Table IV. Measures of all of the bright stars south of declination  $-30^{\circ}$ , are published in Vol. XXXIV.

The stars of the Harvard Photometry were again observed in 1892-1894, and the results are now being published in Vol. XLIV. A large number of them were also measured in 1895-1898, when determining the brightness of stars of the magnitude 7.5 and brighter north of declination  $-40^{\circ}$ . Finally, the stars south of declination  $-30^{\circ}$  are now being remeasured in Arequipa, by Professor Bailey. In a recent letter, he states that sixteen series were obtained on sixteen successive nights, and that 11,448

settings were made during the month of May, 1899. It is hoped that this work will be completed during the present year.

It, therefore, appears that seven photometric catalogues of these stars have been prepared. In Vol. XXIV., Table I., some stars were observed on only two nights, but in all the other catalogues the minimum number of nights is three, and for many of the stars, especially for those that are bright, the number is much greater. When the observations were not accordant the minimum number of nights was five in Vol. XXIV., Part I., and seven or more in the other catalogues. The number of photometric settings on each star each night was generally four, but was occasionally eight or more in the later work. The total number of photometric settings, including those of the fainter stars, will slightly exceed one million. It will be seen, therefore, that a large number of measures of all the bright stars have been made according to the same plan, but with different instruments and by different observers. Each star should appear in at least two of the seven catalogues, and generally in three or more.

It is, therefore, proposed to issue a catalogue of all the stars from the north to the south pole of the magnitude 6.0 or brighter according to the meridian photometer, which will show the brightness as given in each of the seven catalogues. This work, which will be called the 'Revised Harvard Photometry,' will also contain other facts, such as the approximate right ascension and declination for 1900; the designation according to Bayer, Flamsteed, the *Durchmusterung*, the Argentine General Catalogue, the Harvard Photometry and the Southern Harvard Photometry; the magnitude according to Herschel, the *Durchmusterung*, the Argentine General Catalogue, the *Uranometria Oxoniensis*, and the Potsdam Catalogues; the class of spectrum, and, if pos-